SYNOPSIS

ON

DESIGN AND ANALYSIS OF ULTRA WIDEBAND MICROSTRIP ANTENNAS

Submitted in partial fulfillment of requirement for the degree of

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In

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CHAPTER-1
INTRODUCTION

1.1 Microstrip (Patch) Antennas

Microstrip or patch antennas are becoming increasingly useful because they can be printed directly onto a circuit board. Microstrip antennas are becoming very widespread within the mobile phone market. Patch antennas are low cost, have a low profile and are easily fabricated.

Consider the microstrip antenna shown in Figure 1, fed by a microstrip transmission line. The patch antenna, microstrip transmission line and ground plane are made of high conductivity metal (typically copper). The patch is of length *L*, width *W*, and sitting on top of a substrate (some dielectric circuit board) of thickness *h* with permittivity. The thickness of the ground plane or of the microstrip is not critically important. Typically the height *h* is much smaller than the wavelength of operation, but not much smaller than 0.05 of a wavelength.

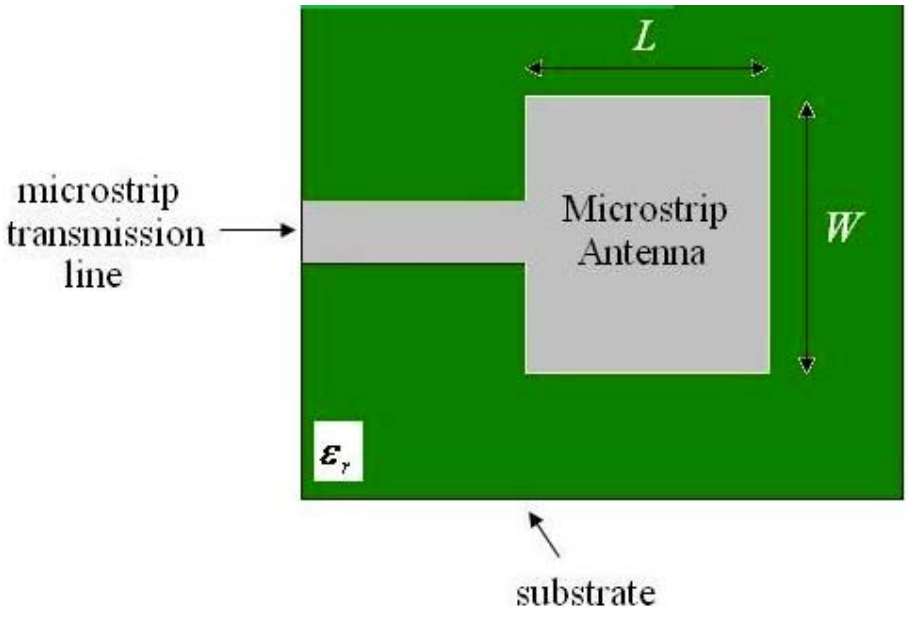
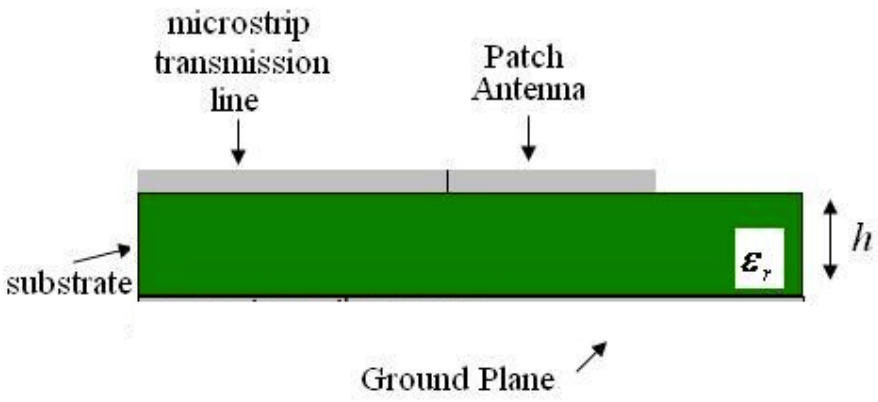


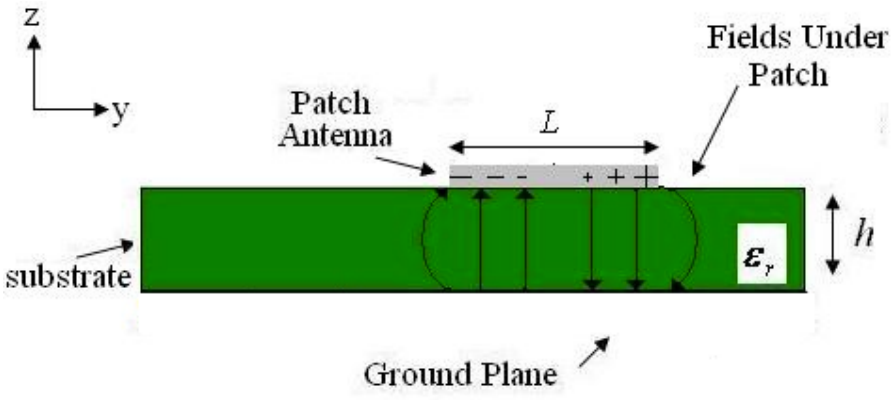
Figure 1(a) Top View of Patch Antenna

A patch antenna is a narrowband, wide-beam antenna fabricated by etching the antenna element pattern in metal trace bonded to an insulating dielectric substrate, such as a printed circuit board, with a continuous metal layer bonded to the opposite side of the substrate which forms a ground plane. Common microstrip antenna shapes are square, rectangular, circular and elliptical, but any continuous shape is possible. Some patch antennas do not use a dielectric substrate and instead made of a metal patch mounted above a ground plane using dielectric spacers; the resulting structure is less rugged but has a wider bandwidth. Because such antennas have a very low profile, are mechanically rugged and can be shaped to conform to the curving skin of a vehicle, they are often mounted on the exterior of aircraft and spacecraft, or are incorporated into mobile radio communications devices.



(b) Side View of Microstrip Antenna

The most commonly employed microstrip antenna is a rectangular patch. The rectangular patch antenna is approximately a one-half wavelength long section of rectangular microstrip transmission line. When air is the antenna substrate, the length of the rectangular microstrip antenna is approximately one-half of a free-space wavelength. The width W of the microstrip antenna controls the input impedance. Larger widths also can increase the bandwidth. For a square patch antenna fed in the manner above.



(c) Side view of patch antenna with E-fields

The frequency of operation of the patch antenna of Figure 1 is determined by the length *L*. The center frequency will be approximately given by:

$$f_r \approx \frac{c}{2L\sqrt{\varepsilon_r}} = \frac{1}{2L\sqrt{\varepsilon_0\varepsilon_r\mu_0}}$$

The above equation says that the microstrip antenna should have a length equal to one half of a wavelength within the dielectric (substrate) medium. The width *W* of the microstrip antenna controls the input impedance. Larger widths also can increase the bandwidth. For a square patch antenna fed in the manner above, the input impedance will be on the order of 300 Ohms. By increasing the width, the impedance can be reduced. However, to decrease the input impedance to 50 Ohms often requires a very wide patch antenna, which takes up a lot of valuable space. The width further controls the radiation pattern.

1.2 Feed Techniques

Inset Feed

Previously, the patch antenna was fed at the end as shown here. Since this typically yields a high input impedance, we would like to modify the feed. Since the current is low at the ends of a half-wave patch and increases in magnitude toward the center, the input impedance

(Z=V/I) could be reduced if the patch was fed closer to the center. One method of doing this is by using an inset feed (a distance R from the end) as shown in Figure 2.

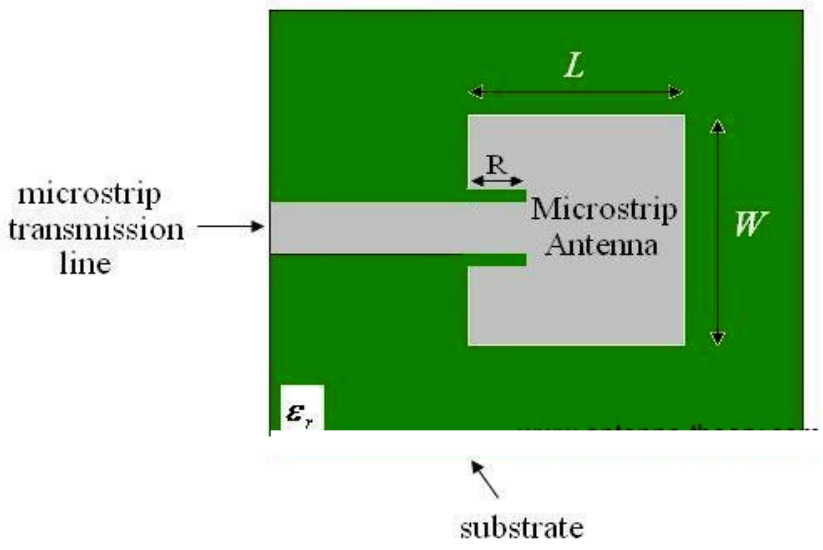


Figure 2. Patch Antenna with an Inset Feed.

Since the current has a sinusoidal distribution, moving in a distance R from the end will increase the current by cos(pi*R/L) - this is just noting that the wavelength is 2*L, and so the phase difference is 2*pi*R/(2*L) = pi*R/L.

The voltage also decreases in magnitude by the same amount that the current increases. Hence, using Z=V/I, the input impedance scales as:

$$Z_{in}(R) = \cos^2\left(\frac{\pi R}{L}\right) Z_{in}(0)$$

In the above equation, Zin(0) is the input impedance if the patch was fed at the end. Hence, by feeding the patch antenna as shown, the input impedance can be decreased. As an example, if R=L/4, then cos(pi*R/L) = cos(pi/4), so that cos(pi/4)]^2 = 1/2. Hence, a (1/8)-wavelength inset would decrease the input impedance by 50%. This method can be used to tune the input impedance to the desired value.

Fed with a Quarter-Wavelength Transmission Line

The microstrip antenna can also be matched to a transmission line of characteristic impedance Z0 by using a quarter-wavelength transmission line of characteristic impedance Z1 as shown in Figure 3.

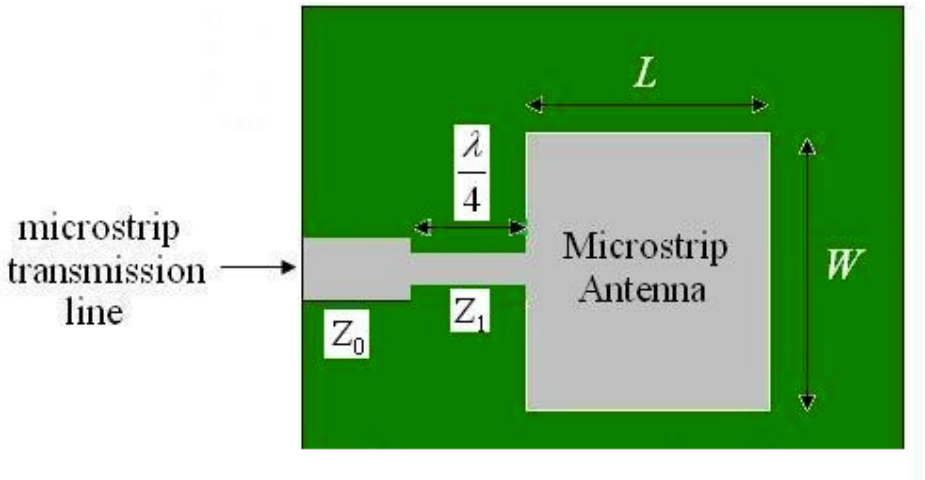


Figure 3. Patch antenna with a quarter-wavelength matching section.

The goal is to match the input impedance (Zin) to the transmission line (Z0). If the impedance of the antenna is ZA, then the input impedance viewed from the beginning of the quarter-wavelength line becomes

$$Z_{in} = Z_0 = \frac{Z_1^2}{Z_A}$$

This input impedance Zin can be altered by selection of the Z1, so that Zin=Z0 and the antenna is impedance matched. The parameter Z1 can be altered by changing the width of the quarter-wavelength strip. The wider the strip is, the lower the characteristic impedance (Z0) is for that section of line.

Coaxial Cable or Probe Feed

Microstrip antennas can also be fed from underneath via a probe as shown in Figure 4. The outer conductor of the coaxial cable is connected to the ground plane, and the center conductor is extended up to the patch antenna.

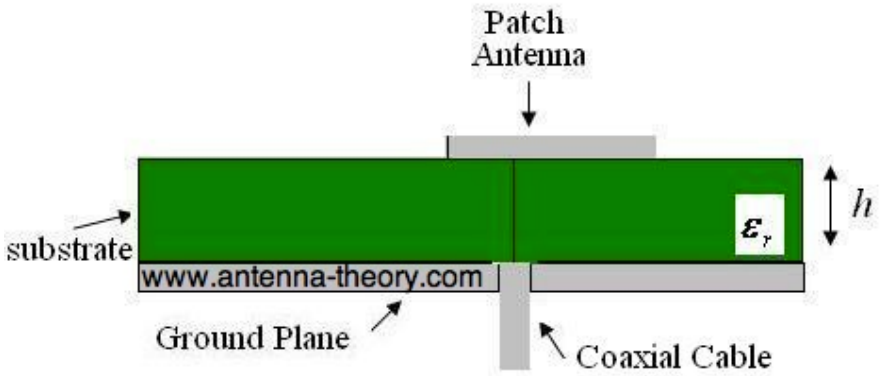


Figure 4. Coaxial cable feed of patch antenna.

The position of the feed can be altered as before (in the same way as the inset feed, above) to control the input impedance. The coaxial feed introduces an inductance into the feed that may need to be taken into account if the height *h* gets large (an appreciable fraction of a wavelength). In addition, the probe will also radiate, which can lead to radiation in undesirable directions.

Coupled (Indirect) Feeds

The feeds above can be altered such that they do not directly touch the antenna. For instance, the probe feed in Figure 4 can be trimmed such that it does not extend all the way up to the antenna. The inset feed can also be stopped just before the patch antenna, as shown in Figure The advantage of the coupled feed is that it adds an extra degree of freedom to the design. The gap introduces a capacitance into the feed that can cancel out the inductance added by the probe feed. Such an array of patch antennas is an easy way to make a phased array of antennas with dynamic beam forming ability. An advantage inherent to patch antennas is the ability to have polarization diversity.

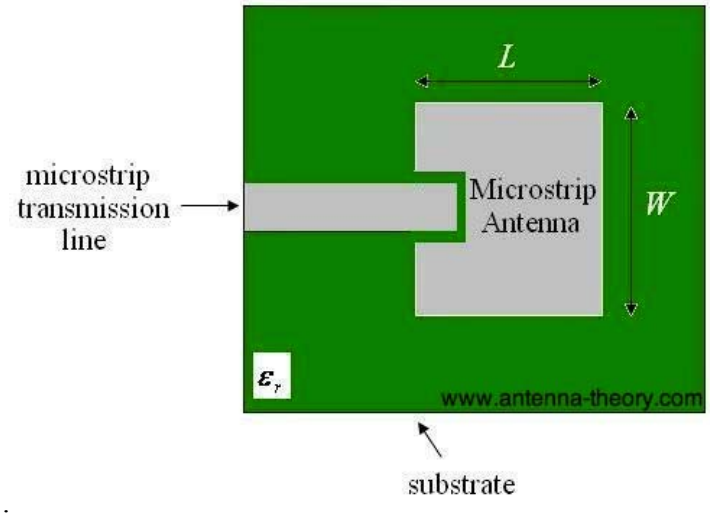


Figure 5. Coupled (indirect) inset feed.

Aperture Feeds

Another method of feeding microstrip antennas is the aperture feed. In this technique, the feed circuitry (transmission line) is shielded from the antenna by a conducting plane with a hole (aperture) to transmit energy to the antenna, as shown in Figure 6.

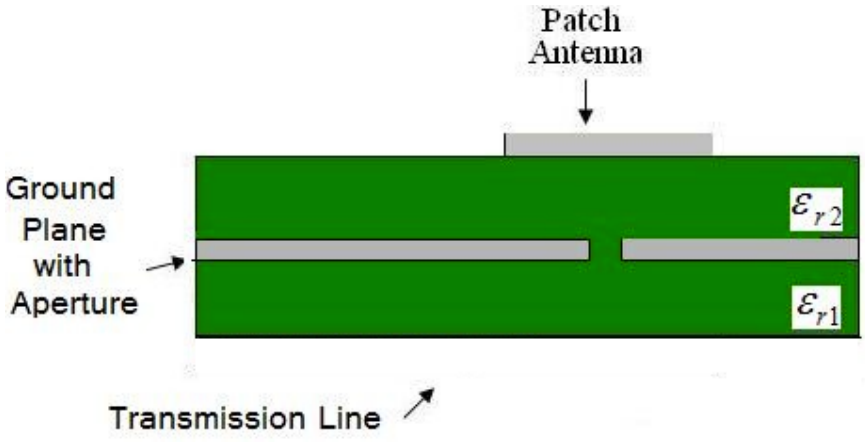


Figure 6. Aperture coupled feed.

The upper substrate can be made with a lower permittivity to produce loosely bound fringing fields, yielding better radiation. The lower substrate can be independently made with a high value of permittivity for tightly coupled fields that don't produce spurious radiation. The disadvantage of this method is increased difficulty in fabrication.

Microstrip Patch antennas radiate primarily because of the fringing fields between patch edge and ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant is desirable since ths provides better efficiency, large bandwidth and better radiation.

1.3 Advantages

Microstrip antennas are relatively inexpensive to manufacture and design because of the simple 2-dimensional physical geometry. They are usually employed at UHF and higher frequencies because the size of the antenna is directly tied to the wavelength at the resonant frequency. A single patch antenna provides a maximum directive gain of around 6-9 dBi. It is relatively easy to print an array of patches on a single (large) substrate using lithographic techniques. Patch arrays can provide much higher gains than a single patch at little additional cost; matching and phase adjustment can be performed with printed microstrip feed structures, again in the same operations that form the radiating patches. The ability to create high gain arrays in a low-profile antenna is one reason that patch arrays are common on airplanes and in other military applications.

Such an array of patch antennas is an easy way to make a phased array of antennas with dynamic beam forming ability. An advantage inherent to patch antennas is the ability to have polarization diversity. Patch antennas can easily be designed to have vertical, horizontal, right hand circular (RHCP) or left hand circular (LHCP) polarizations, using multiple feed points, or a single feed point with asymmetric patch structures. This unique property allows patch antennas to be used in many types of communications links that may have varied requirements.

Microstrip antennas are used as embedded antennas in handheld wireless devices such as cellular phones, and also employed in Satellite communications. Some of their principal advantages are given below:

a) Light weight and low fabrication cost.
b) Supports both, linear as well as circular polarization.
c) Can be easily integrated with microwave integrated circuits.
d) Capable of dual and triple frequency operations.
e) Mechanically robust when mounted on rigid surfaces.

1.4 Disadvantages

Microstrip patch antennas suffer from more drawbacks as compared to conventional antennas. Some of their major disadvantages are given below:

a) Narrow bandwidth.
b) Low efficiency and Gain.
c) Extraneous radiation from feeds and junctions.
d) Low power handling capacity.
e) Surface wave excitation.

1.4 PCB SUBSTRATE MATERIAL

In today's market there are a lot of different PCB substrate products. Unfortunately there is not only one product that can cover all applications. It all depends on the application itself. Even though your application is simple it is still difficult to meet all requirements. Depending on your application you need to consider your selection of substrate. Properties to be considered for substrate material are

- Dielectric constant
- Loss tangent
- Variation with temperature

- Frequency
- Dimensions
- Stability
- Thickness
- Resistance to chemicals
- Flexibility etc.

1.5.1 Substrate Properties

1.5.1.1 Dielectric constant

The dielectric constant ("relative static permittivity") is the ratio between the stored amount of electrical energy in a material and to that stored by a vacuum (which is by definition 1). It is also a measure of the degree to which an electromagnetic wave is slowed down as it travels through the insulating material. Dielectrics are i.e. used in capacitors to store more electrical charge than vacuum.

The lower the dielectric constant is, the better the material works as an insulator. The better and insulator, the better it resists electrons from being absorbed in the dielectric material, creating less loss.

1.5.1.2 Loss Tangent

The loss tangent (also called "tan δ", "DF", "low loss", "dissipation factor") is a measure of how much of the electromagnetic field traveling through a dielectric is absorbed or lost in the dielectric, usually through heat.As the dielectric in a substrate is similar to the dielectric in a capacitor, the loss tangent can best be described as the loss through an equivalent series resistor (ESR) inside a capacitor. A small ESR describes a good capacitor with low loss.

The loss tangent is often thought of as power loss and might have a low number at first glance The loss tangent also varies with frequency and temperature depending on which material is used. The higher loss tangent, the higher loss you will have in the dielectric, which leads to reduced antenna efficiency.

1.5.1.3 Thickness

The thinner the substrate is, the less loss, but the less power you can send through it, because the transmission line has to be thinner to keep the same impedance. With a thicker substrate you need a wider strip line to keep the same impedance. This will give a higher Q in the copper = more power through it, while the disadvantage will be more weight and higher radiated power from the transmission line which we want as little as possible.

As an alternative you could use a substrate with a lower dielectric constant, because that way you can increase the microstrip line (transmission line) = higher Q, without increasing the thickness of the substrate.The thickness also depends on your application. For instance: a designer wants to design a thin mobile phone because that attracts certain customers. This means that there is use for a thinner substrate and you therefore have to cater to it.

1.5.1.4 Dielectric strength

The dielectric strength (also called "Electric strength") is how much potential (voltage) the dielectric material can resist before it makes a dielectric breakdown. A dielectric breakdown is when the dielectric material is damaged and could mean that the material doesn't work as an insulator anymore, which will lead to short circuiting. This property will only be useful in high power/high voltage applications. Here follows some critical properties which should be considered for power/high voltage applications:

•The dielectric strength increases if the material thickness increases.

•The dielectric strength decreases if the frequency increases.

•The dielectric strength decreases if the temperature increases.

•The dielectric strength decreases if the humidity increases.

Dielectric voltage breakdown is not really an issue as most laminates can withstand high power voltage such as 20 kV/mm.

1.5.2 Substrate Material

1.5.2.1 Ceramic substrate

The ceramic substrate is mainly used in small size applications with frequencies below 1 GHz

It has low a loss tangent and has good chemical resistance, but is also very expensive. Besides that, ceramic is very hard to produce and handle. For instance it is very hard to drill holes in the substrate without breaking it. Some ceramic material has a high dielectric constant which is used where you need an important size reduction.

1.5.2.2 Synthetic substrate

Synthetic substrate is commonly made out of organic material like PTFE (also known as Teflon). These materials possess low loss tangent and low Ɛr. The only problem is that this material is very soft and can therefore easily change the characteristics of a microstrip antenna if it is not handled well enough.

1.5.2.3 Composite material substrate

Composite material is made out of mixed chemicals between fiberglass, ceramic or quartz and synthetic material. There is a wide variety of composite material on the market which has been modified so they fit both to antenna fabrication and standard PCB design.

1.5.2.4 FR-4

FR-4 substrate is a very common and by far the most used substrate in consumer electronics market as it has a good quality-to-price ratio. It is mostly used where cost is more efficient than performance.

FR-4 is a standard with many different distributors making many different FR-4 quality and property boards. It is made of woven fiberglass with an epoxy resin binder (binds the copper clad to the dielectric substrate) that is flame resistant. The dielectric constant goes down the more the FR-4 PCB is reinforced with epoxy resin instead of fiberglass as this is not determined as a standardized parameter. 100% epoxy resin boards has a dielectric constant of 3.4 @ 1MHz.

The FR-4 changes it's dielectric constant along its area which makes it too unstable to mass produce precise antennas on it. Also, the FR-4 is has a higher loss at frequencies over 3GHz, because of the sensitivity of the cheap substrate. Other products are therefore recommended to perform better than FR-4 in RF applications. A highly recommended distributor is Rogers, who is a little more expensive but performs much better in RF applications.

In the cellphone industry, companies uses higher quality FR-4 substrate because it is more cost efficient, but from only one manufacture so they can be sure of the quality and properties when mass producing.

1.6 Antenna Parameters

An **antenna** (or **aerial**) is an electrical device which converts electric power into radio waves, and vice versa.[1] It is usually used with a radio transmitter or radio receiver. In transmission, a radio transmitter supplies an electric current oscillating at radio frequency (i.e. a high frequency alternating current (AC)) to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of an electromagnetic wave in order to produce a tiny voltage at its terminals, that is applied to a receiver to be amplified.

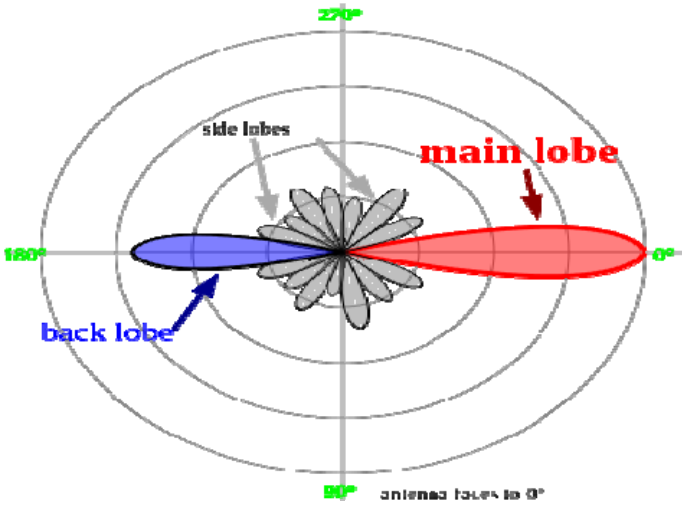
Antennas are essential components of all equipment that uses radio. They are used in systems such as radio broadcasting, broadcast television, two-way radio, communications receivers, radar, cell phones, and satellite communications, as well as other devices such as garage door openers, wireless microphones, Bluetooth-enabled devices, wireless computer networks, baby monitors, and RFID tags on merchandise.

Antennas can be designed to transmit and receive radio waves in all horizontal directions equally (omnidirectional antennas), or preferentially in a particular direction (directional or high gain antennas). In the latter case, an antenna may also include additional elements or surfaces with no electrical connection to the transmitter or receiver, such as parasitic elements, parabolic reflectors or horns, which serve to direct the radio waves into a beam or other desired radiation pattern.

(a) Radiation Pattern

The radiation pattern of an antenna is a plot of the relative field strength of the radio waves emitted by the antenna at different angles. It is typically represented by a three-dimensional graph, or polar plots of the horizontal and vertical cross sections. The pattern of an ideal isotropic antenna, which radiates equally in all directions, would look like a sphere. Many nondirectional antennas, such as monopoles and dipoles, emit equal power in all horizontal directions, with the power dropping off at higher and lower angles; this is called an

omnidirectional pattern and when plotted looks like a torus or donut.The radiation of many antennas shows a pattern of maxima or "lobes" at various angles, separated by "nulls", angles where the radiation falls to zero. This is because the radio waves emitted by different parts of the antenna typically interfere, causing maxima at angles where the radio waves arrive at distant points in phase, and zero radiation at other angles where the radio waves arrive out of phase. In a directional antenna designed to project radio waves in a particular direction, the lobe in that direction is designed larger than the others and is called the "main lobe". The other lobes usually represent unwanted radiation and are called "sidelobes". The axis through the main lobe is called the "principal axis" or "boresight axis".



. Figure 7 Radiation Pattern

(b) Gain

Antenna gain is the ratio of maximum radiation intensity at the peak of main beam to the radiation intensity in the same direction which would be produced by an isotropic radiator having the same input power. Isotropic antenna is considered to have a gain of unity. The gain function can be described as:

$G\ \theta,\emptyset = P(\theta,\emptyset)/Wt4\pi$, where$P(\theta,\emptyset)$ is the power radiated per unit solid angle in the direction$(\theta,\emptyset)$ and Wt is the total radiated power.

Microstrip antennas because of the poor radiation efficiency have poor gain. Numerous researches have been conducted in various parts of the world in order to obtain high gain antennas.

(c) Directivity

If a three dimensional antenna pattern is measured, the ratio of normalized power density at the peak of the main beam to the average power density is called the directivity.

The directivity of the antenna is given by:

$D=Pmax/Pav$

(d) Effective area

The effective area or effective aperture of a receiving antenna expresses the portion of the power of a passing electromagnetic wave which it delivers to its terminals, expressed in terms of an equivalent area. For instance, if a radio wave passing a given location has a flux of 1 pW / m^2 (10^{-12} watts per square meter) and an antenna has an effective area of 12 m^2, then the antenna would deliver 12 pW of RF power to the receiver (30 microvolts rms at 75 ohms). Since the receiving antenna is not equally sensitive to signals received from all directions, the effective area is a function of the direction to the source.

Due to reciprocity (discussed above) the gain of an antenna used for transmitting must be proportional to its effective area when used for receiving. Consider an antenna with no loss, that is, one whose electrical efficiency is 100%. It can be shown that its effective area averaged over all directions must be equal to $\lambda^2/4\pi$, the wavelength squared divided by 4π. Gain is defined such that the average gain over all directions for an antenna with 100% electrical efficiency is equal to 1. Therefore the effective area A_{eff} in terms of the gain G in a given direction is given by:

$$A_{eff} = \frac{\lambda^2}{4\pi} G$$

(e) Bandwidth

It is defined as "The range of usable frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard." The bandwidth can be the range of frequencies on either side of the center frequency where the antenna characteristics like input impedance, radiation pattern, beam width, polarization, side lobe level or gain, are close to those values which have been obtained at the center frequency.

CHAPTER-2
REVIEW OF LITERATURE

To meet the miniaturization requirement, compact antennas are required. Planar printed antennas have the attractive features of low profile, small size and conformability to mounting hosts. Wireless communications have progressed very rapidly in recent years,and many mobile units are becoming smaller and smaller. They are very promising candidates for satisfying the above applications. For this reason, compact and broadband design techniques for planar antennas have attracted much attention from antenna researchers.
In this section some of the works related to microstrip antenna and applications have been referred and discussed.

Jeen-Sheen Row and Jia-Fu Tsai [1] proposed a simple design of circularly-polarized (CP) microstrip antennas with frequency agility is described. The reconfigurable antenna is composed of a square radiating patch, four varactor diodes, and two lumped capacitors.With a coaxial probe, two orthogonal resonant modes of the square patch antenna are simultaneously excited. When the equivalent capacitance values of the varactors are increased, the resonant frequencies of the two modes are decreased, and at the same time the lumped capacitors with a specific value are introduced to produce a difference between the two resonant frequencies so that a CP operating frequency can be generated and tuned. For the proposed design, only one dc voltage is required to vary the CP operating frequency, and experimental results indicate that the CP frequency can be switched between 1.97 GHz and 2.53 GHz; in addition, good CP performances can be obtained at each CP operating frequency.

A compact CPW-fed triple-band antenna for WLAN and WiMAX applications presented by Y. Xu, Y.-C. Jiao and Y.-C. Luan [2]. The novel antenna is consists of a rectangular ring as well as an S-shaped strip attached to the feed line, a crooked U-shaped strip and three straight strips on the back. Both the simulated and measured results has shown that the demonstrated antenna can successfully obtained three operating bands, covering both the 2.4/5.2/5.8 GHz WLAN and 3.5/5.5 GHz WiMAX standards. In addition, the proposed antenna has good radiation patterns and stable gains in the working bands. This compact triple-band antenna is a suitable candidate for wireless communication systems.

Pei-Yuan Qin et.al.[3] presented A new antenna with both frequency and polarization reconfigurability is presented. The antenna consists of a square microstrip patch with a single probe feed located along the diagonal line. The center of each edge of the patch is connected to a shorting post via a p-i-n diode for polarization switching and two varactor diodes for frequency tuning. By switching between the different states of the p-i-n diodes, the proposed antenna can produce radiation patterns with horizontal, vertical, or 45 linear polarization.
By varying the dc bias voltage, the operating frequency of each polarization of the antenna can be independently tuned. The frequency tuning range is from 1.35 to 2.25 GHz for either horizontal or vertical polarization and from 1.35 to 1.9 GHz for the 45 linear polarization. Measured results on frequency tuning ranges and radiation patterns agree well with numerical simulations.

Sarin et al. [4]. Presented a wide band printed microstrip antenna has been proposed for Wireless communications by This is an electromagnetically coupled strip loaded slotted broad band microstrip antenna having 38% impedance bandwidth.

Gopikrishna et al. [5] proposed a compact semi-elliptic monopole slot antenna for UWB Systems. The antenna features a coplanar waveguide signal strip terminated with a semi-elliptic stub and a modified ground plane to achieve wide bandwidth from 2.85-20 GHz.

Laila et al. [6] presented a Compact asymmetric coplanar strip fed antenna has been proposed for wideband application by In this configuration wide bandwidth is obtained by merging three resonances at 1.85GHz, 3.18GHz and 4.4GHz.

Deepu et al. [7] presented an ACS fed printed F-shaped uniplanar antenna for dual band WLAN applications. Asymmetric coplanar strip is used as the feed for this uniplanar configuration.

Deepu et al. [8] presented a slot line fed dipole antenna with a parasitic element for wide band applications. The presented antenna offers a 2:1 VSWR bandwidth from 1.66 to 2.71 GHz with a gain better than 6.5 dBi. The parasitic element improves the bandwidth and gain of the antenna.

Yang and Yan [9] proposed a Dualband Printed Monopole Antenna for WLAN applications. The microstrip fed printed monopole consists of a P shaped radiating element. Antenna is resonating at 2.45 GHz with a –10 Db impedance bandwidth of 360 MHz (2.28–2.64 GHz) and at 5.8 GHz with an impedance bandwidth of 1.45 GHz (4.92–6.37GHz). DCS-1800, IMT-2000, and WLAN Applications. The planar antenna consists of an S-strip and a T-strip, which are separately printed on the two sides of a thin substrate. The antenna size is only 18 mm X 7.2 mm X 0.254 mm. The bandwidth of the planar antenna is enhanced by the mutual coupling between the S-strip and the T-strip.

A dual wide-band CPW-fed modified Koch fractal printed slot antenna, suitable for WLAN and WiMAX operations is proposed by Krishna et al. [10].Here the operating frequency of a triangular slot antenna is lowered by the Koch iteration technique resulting in a compact antenna. Koch fractal slot antenna has an impedance bandwidth from 2.38-3.95GHz and 4.95–6.05GHz covering 2.4/5.2/5.8GHz WLAN bands and the 2.5/3.5/5.5 GHz WiMAX bands.

A compact dual band planar antenna has been proposed by Gijo Augustin et al. [11]. It is a Finite Ground CPW fed, dual-band monopole configuration. The dual-band operation is achieved by loading the flared monopole antenna with a “V”-shaped sleeve.

Bybi et al. [12] presented a quasi-omnidirectional antenna for modern wireless communication gadgets. The antenna has been derived from the conventional CPW by embedding a modified short, which results in an appreciable improvement in the impedence bandwidth while retaining an almost omnidirectional radiation behavior.

Deepti Das Krishna et al. [13] proposed an ultra-wideband slot antenna for wireless USB dongle applications. The design comprises a nearrectangular slot fed by a coplanar waveguide printed on a PCB of width 20 mm. The proposed design has a large bandwidth covering the 3.1-10.6 GHz UWB band and omnidirectional radiation patterns.

A novel modified T shaped planar monopole antenna has been proposed for multiband operation by Sheng Bing Chen et al. in [14]. In this paper, a T-shaped planar monopole antenna in that two asymmetric horizontal strips are used as additional resonators to produce the lower and upper resonant modes are proposed. As a result, a dual-band antenna for

covering 2.4 and 5-GHz wireless local area network (WLAN) bands is implemented. In order to cover simultaneously the DCS, PCS, and UMTS bands, the right horizontal strip has been widened and introduced an Lshaped notch in the right horizontal strip.

Suma et al. [15] proposed a Compact Dual Band Planar Branched Monopole Antenna for DCS/2.4GHz WLAN Application. The two resonant modes of the proposed antenna are associated with various lengths of the monopoles, in which a longer arm contributes for the lower resonant frequency and a shorter arm for higher resonant frequency.

Raj et al. [16] discussed a compact dual band coplanar antenna for WLAN application. The antenna comprises of a rectangular center strip and two lateral strips printed on a dielectric substrate and excited using a 50Ω microstrip transmission line. The lower resonant frequency of the antenna is due to a "U" shaped resonant path on the center strip and the upper resonant frequency is obtained due to the width of the center strip, corresponding to a half wavelength variation in substrate.

Cho et al. [17] proposed a PIFA configuration for 2.4/5GHz applications. This configuration offers 110MHz bandwidth in Bluetooth band and 900MHz in WLAN band.

Liu and Hsu [18] proposed a Dual-band CPW-fed Y-shaped monopole antenna for PCS&WLAN application. In this paper a rectangular notch is introduced to expand the impedance bandwidth of a dual-band planar monopole antenna. The antenna is fed by a CPW line and resembles the shape of the letter 'Y'. Antenna exhibits 14.4% and 34.1% bandwidths for the lower (1.95GHz) and upper (5.45GHz) bands which covers PCS and WLAN bands.

Jacob et al. [19] proposed the development of a compact microstrip-fed, branched monopole antenna for ultra wide band (UWB) applications. By suitably embedding branches on the top edge of the strip monopole, UWB response can be easily achieved by merging different resonances.

Liu [20] proposed a CPW-fed notched planar monopole antenna for multiband operations using a genetic algorithm. By introducing a suitable notch to a rectangular CPW-fed patch, the desired multi-frequency resonant modes and broad impedance bandwidths can be obtained.

A Dual Band CPW-Fed Printed T-Shaped Planar Antenna has been proposed by Qiu et al. [21]. The proposed antenna comprised of two horizontal arms of different lengths and an L-shaped shorted strip, which connects between the vertical arm and the ground plane. It has been reported that the short-circuiting L-shaped element is the key component responsible for the two separate resonant modes. It introduces additional inductance to compensate for the large capacitance contributed from the area between the designed antenna and the ground plane, thus helping to generate two different resonant modes at 1.8GHz and 2.4GHz respectively.

Jung et al. [22] proposed a Wideband monopole antenna for various mobile communication applications. This design is basically a microstrip fed printed monopole configuration, which consists of a radiating patch with two L-shaped notches and stubs at the lower corners with a truncated ground plane. A wideband characteristic of the proposed antenna is easily achieved by cutting two L-shaped notches and attaching two stubs to the radiating patch. The L-shaped notches of suitable dimensions improve impedance matching performance at middle frequencies within the bandwidth of interest. To achieve good impedance matching at higher frequencies, two stubs are appended to the radiating patch.

Amman and John [23] have presented an optimum design for the printed strip monopole. In this paper a microstrip fed printed monopole antenna has been studied and effect of ground plane dimensions on impedance bandwidth and radiation pattern have been investigated. It is reported that the impedance bandwidth of the printed monopole was strongly dependant on the ground plane dimensions.

Jean Yea Jan et al. [24] proposed a microstrip fed dual band planar monopole antenna with shorted parasitic inverted L wire for 2.4/5.2/5.8 WLAN bands. In this design inverted L shaped monopole is the exciting element and which controls the higher frequency. Another shorted inverted L shaped parasitic strip etched nearer to the monopole controls the lower frequency.

Lethakumary et al. [25] introduced a hook shaped feeding technique for bandwidth enhancement of a rectangular microstrip antenna. This antenna offers an impedance bandwidth of 22% without degrading the efficiency.

Zi Dong Liu et al. [26] presented a dual frequency planar inverted-F antenna which operates at 0.9GHz and 1.8GHz bands. In this paper two configurations of dual band antennas are proposed. The antenna with two input ports and single-port are described. The two port antenna consists of two separate radiating elements with the rectangular radiating element for 1.8 GHz and the L-shaped radiating element for 0.9 GHz.

OBJECTIVES OF RESEARCH

As the major issue in Microstrip antenna is regarding bandwidth of antenna. For large number of wireless applications basically antenna with wide bandwidth is required.

So main objectives of proposed research are as follows:

- To design and simulate Ultra wideband Microstrip Antennas with different attributes.
- Bandwidth augmentation of Ultra wideband Microstrip Antennas.
- Development and testing of Ultra Wideband Microstrip Antennas.
- Comparative analysis of different types of designed Antennas.

RESEARCH METHODOLOGY

Bandwidth of patch antenna can be increased by following methods :-

- Decreasing the Q factor of patch by increasing substrate height & decreasing the dielectric constant.
- Use the multiple resonator located in one plane.
- Electromagnetically coupled patch Antenna.
- Use of multilayer configuration with multilayer resonators stacked vertically.

TOOLS

IE3D and **HFSS** software will be used.

Spectrum analyzer is used for testing the microstrip antennas.

STUDY PLAN

SCHEDULE FOR STUDY THE DESIGN AND ANALYSIS OF ULTRA WIDEBAND MICROSTRIP ANTENNAS																
S.No.		Activity	Year													
			2014		2015				2016				2017			
			Qtr.3	Otr. 4	Qtr.1	Otr. 2	Qtr.3	Otr. 4	Qtr.1	Otr. 2	Qtr.3	Otr. 4	Qtr.1	Otr. 2	Qtr.3	Otr. 4
1	STUDY	Study of Ultra Wideband Microstrip Antennas														
2	DESIGN	Design of Ultra Wideband Microstrip Antennas														
		Design of Ultra Wideband Microstrip Antennas with Different Substrates & different shapes of Patches														
		Simulation of Ultra Wideband Microstrip Antennas using software														
3	IMPLEMENT	Development and testing of Ultra Wideband Microstrip Antennas														
4	ANALYSIS	Comparison of designed Antennas														
5	FINALIZATION	Preparation of Thesis														

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